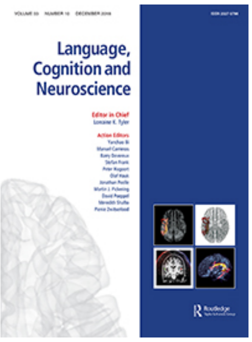

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The cat in the tree – using picture descriptions to inform our understanding of conceptualisation in aphasia

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ABSTRACT

Conceptualisation is the first step of speech production and describes the process by which we map our thoughts onto spoken language. Recent studies suggest that some people with language impairments have conceptualisation deficits manifested by information selection and sequencing difficulties. In this study, we examined conceptualisation in the complex picture descriptions of individuals with and without aphasia. We analysed the number and the order of main concepts (ideas produced by ≥60% of unimpaired speakers) and non-main concepts (e.g. irrelevant details). Half of the individuals with aphasia showed a reduced number of main concepts that could not be fully accounted for by their language production deficits. Moreover, individuals with aphasia produced both a larger amount of marginally relevant information, as well as having greater variability in the order of main concepts. Both findings provide support for the idea that conceptualisation deficits are a relatively common impairment in people with aphasia.

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"Where shall I begin, please your Majesty?" he asked. "Begin at the beginning," the King said, very gravely, "and go on till you come to the end: then stop." **Lewis Carroll**, Alice's Adventures in Wonderland (p. 182)

Every one of us tells stories in our daily conversations. We talk about our experiences and important events in our lives without any effort and with only rare misunderstandings by the listener. But how do we decide where to begin such a story, which information to choose and how to order it? Before we are actually able to start speaking we need to think about, and plan, what we are going to say. Moreover, we need to make this plan quickly to keep the conversation smooth. Levelt (1989) describes this pre-linguistic stage of speaking as "*conceptualisation*". Nevertheless, what seems so easy to us as unimpaired speakers may pose considerable problems to individuals with acquired language impairments. Surprisingly, however, little is known about the interaction between an individual's conceptualisation and his/her language abilities. In this paper, we aim to investigate this interaction in more detail by examining what data from picture description can tell us about an individual's conceptualisation and/or possible conceptualisation deficits.

What is conceptualisation?

Conceptualisation can be understood as the process of forming general ideas on the basis of specific observations and experiences (Chafe, 1990). However, the linguistic literature lacks a concrete definition of the term. Consequently, there are a variety of different understandings of "conceptualisation". Cognitive linguists have described conceptualisation as an umbrella term that encompasses abstract entities like thoughts and more concrete sensory experiences like the smell or appearance of objects (Langacker, 1986). Conceptualisation has also been described as the mind's ability to "build models of the world" (Chafe, 1990, p. 90) which is influenced by our expectations, previous knowledge and the context of a specific situation (Chafe, 1990; Langacker, 1986).

In this paper, we focus on conceptualisation as a part of the speech production process. Levelt (1989) describes conceptualisation as the first step of speech production, which entails two main processes: the *macroplanning* and the *microplanning*. During macroplanning we form a speaking intention, select the necessary information and order this information in a

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way that makes it easy for the listener to follow. Microplanning is a more finely grained process in which we shape the message into a linguistic structure that can be further processed (e.g. assigning thematic roles). In other words, during conceptualisation we transform our thoughts into a structure that can be verbally expressed.

During the conceptualisation process, the linguistic constraints of the language we speak direct our attention to features of the message (e.g. type of motion, orientation of a surface) that we are able to express and/or features that are required to perfectly prepare our message for further processing ("Thinking for Speaking"; e.g. Dipper, Black, & Bryan, 2005; Slobin, 1996). Even though this strong interaction between thinking and speaking is well described in the literature (e.g. Black & Chiat, 2000; Cairns, Marshall, Cairns, & Dipper, 2007; Dipper et al., 2005; Marshall, Pring, & Chiat, 1993; Slobin, 1996), surprisingly little is known about conceptualisation processes in individuals with acquired language impairments (e.g. stroke-induced aphasia).

Conceptualisation deficits in aphasia

Dipper et al. (2005) argue that language impairment might reduce the linguistic constraints that are necessary to optimally prepare a message for speech production, resulting in the production of a linguistically incorrect phrase ("spiral of impairment"; Black & Chiat, 2000). Dipper et al. (2005) propose that, under these circumstances, an individual with aphasia would experience problems at the microstructural conceptualisation level (e.g. choosing a perspective, determining an argument structure). In the individual's spontaneous speech, the symptoms of the effects of linguistic impairments on microstructural planning would be hard to distinguish from purely linguistic deficits (e.g. word retrieval, agrammatism), and indeed from "pure" microstructural impairments. In this paper, we focus on the macrostructural level, and aim to tease apart linguistic impairments and (non-linguistic) conceptualisation impairments.

A small number of single case studies have described individuals with aphasia who have been argued to show symptoms that could be associated with conceptualisation deficits at the macrostructural level (e.g. Cairns et al., 2007; Marshall, 2009). Cairns et al. (2007) described the case of Ron. His spontaneous speech was agrammatic, characterised by noun and verb retrieval difficulties with a high proportion of noun-phrases and few verb-argument structures. Cairns and colleagues evaluated Ron's ability to process depicted events using a picture description task (Order of Naming Test; Cairns, 2006). The stimuli consisted of simple action pictures with three entities (agent, patient and instrument; e.g. a depiction of a fairy spraying a swimmer using a hose). Ron mentioned many details of the picture, for example: "*tap, hose, and pixies, elf, woman long hair – no short – no bob and pixie and then swimming woman, and cap, obviously, and (gestures goggles)*" (Marshall, 2009, p. 6). In contrast, most unimpaired participants restricted their picture descriptions to the three depicted entities (e.g. "The fairy sprays the swimmer with a hose."). The authors interpreted Ron's overly detailed descriptions as an inability to select the most important information (Cairns et al., 2007). Indeed, even when Ron was asked to simply name the depicted entities, he listed about eight different objects, while unimpaired participants never mentioned more than three. In addition to Ron, we found only two further individuals with aphasia who have been reported to produce a large proportion of information unrelated or marginally relevant to the event (e.g. clothing of depicted entities) in a picture description task (Dean & Black, 2005; Marshall et al., 1993). Both were described as having a primarily agrammatic symptom pattern, like Ron.

Moreover, Ron produced the entities he mentioned in a seemingly random order, while unimpaired participants tended to mention the individual entities in the order in which they appeared in a sentence. Similarly, Manning and Franklin (2016) observed temporal sequencing errors in the Cinderella narratives of some of the 22 people with aphasia and 10 unimpaired speakers. In this experiment, the participants were reminded of the Cinderella story using picture cards supplement by a brief description by the experimenter and then told to freely retell the story. Manning and Franklin analysed the macrostructural (e.g. story elements, discourse marker, temporal sequencing) and microstructural features (e.g. omission of verbs, incorrect use of pronouns) of the narratives. They found that individuals with aphasia produced significantly more sequencing errors than unimpaired speakers (e.g. "the prince and the princess were dancing […] *Cinders was going to the ball", Manning & Franklin, 2016, p. 423). Interestingly, Manning and Franklin did not find any significant correlations between microstructural deficits (e.g. omission of verbs or wrong pronoun use) and temporal sequencing errors. Consequently, the authors suggested that temporal sequencing does not seem to be influenced by linguistic deficits at the microstructural level.

Sequencing errors were also observed in the study by Carragher, Sage, and Conroy (2015). Two of their four participants with aphasia produced simple video recounts out of sequence (e.g. Scene 1 - 3 - 2 - 4). When the narrative became more complex (more than 2 actors, 6 scenes) all of the language impaired participants produced at least one sequencing error. In contrast no such errors were observed in the narratives of unimpaired control participants.

Another case (LC) with presumed conceptualisation difficulties is reported by Byng, Nickels, and Black (1994). While LC did not produce overly detailed picture descriptions or sequencing errors, she presented with considerable verb processing difficulties and showed deficits when discriminating pictures of events (e.g. someone driving a car; a newspaper being blown along the street) and non-events (e.g. an empty street). Similarly, the participant, MM, described by Marshall et al. (1993) had difficulties identifying the same action when it was depicted in different contexts (e.g. pushing a pram vs. pushing a wheelbarrow). Finally, Dean and Black (2005) found that the verb production of the case reported (EM) in their study was affected by conceptual verb features (e.g. situation type) rather than by features like frequency and/or familiarity. Dean and Black argued that these symptoms might be underpinned by an impairment in the connection between general event processing (e.g. identifying relationships between entities) and the language structures used to describe events (e.g. verbs, argument structure). Thus, verbal and non-verbal event processing difficulties may be valuable predictors of (macrostructural) conceptualisation impairments in people with aphasia (Byng et al., 1994; Cairns et al., 2007; Marshall et al., 1993).

To summarise, based on the literature, there are three possible symptoms that may be associated with underlying conceptualisation problems: (1) reduced informativeness (Cairns et al., 2007; Carragher et al., 2015; Marshall et al., 1993), (2) large numbers of irrelevant details (Cairns et al., 2007; Dean & Black, 2005; Marshall et al., 1993) and (3) content sequencing errors (Cairns et al., 2007; Carragher et al., 2015; Manning & Franklin, 2016).

Considering the strong link between conceptualising and speaking we were surprised by how few cases have been reported with symptoms that point to a conceptualisation deficit. Hence, we were interested if these symptoms could be observed in a larger population of individuals with aphasia using a clinically feasible picture description task.

Investigating conceptualisation in narrative discourse

Narratives are not merely descriptive listings of events and facts, they also reflect our representations of the world (Chafe, 1990). Thus, narrative discourse can tell us a lot about how individuals perceive the events they talk about. A wide variety of structural (e.g. Marini, 2012; Prins & Bastiaanse, 2004) and functional (e.g. Armstrong, 2000; Armstrong, Ferguson, & Simmons-Mackie, 2013) analysis approaches have been used to evaluate specific linguistic features (e.g. use of verbs or pronouns) and discourse pragmatic (e.g. turn-taking behaviour) in aphasia and unimpaired individuals. However, general conceptual processes underpin our ability to make discourse (Langacker, 2008; Levelt, 1989) and hence, people with aphasia who experience conceptual impairments would be predicted to make discourse errors. Specifically, we would expect them to show impairments in macrostructural features such as information selection and information ordering and/or microstructural features like perspective taking (e.g. Cairns et al., 2007; Marshall, 2009).

Few discourse analysis approaches have focused on the selection of discourse information and the quality of the content. Yorkston and Beukelman (1980) presented pioneering work in this field. They analysed content units in the picture descriptions of unimpaired and language-impaired speakers (Cookie Theft; Goodglass, Barresi, & Kaplan, 1983). Content units were defined as “a grouping of information that was always expressed as a unit” (Yorkston & Beukelman, 1980, p. 30). Although this analysis provided some information about the informativeness of the participants’ picture description, it did not evaluate whether these content units were used in a context that described the depicted scene.

Nicholas and Brookshire (1993, 1995) and Richardson and Dalton (2016) analysed the informativeness of a picture description by focusing on the concepts produced. When looking at the picture descriptions of unimpaired speakers, they defined concepts as statements that contained one main verb only and represent the essential information of the depicted event (Nicholas & Brookshire, 1995). Nicholas and Brookshire (1995) asked 10 experienced speech pathologists to provide a written description of the Cookie Theft picture descriptions and collected oral descriptions of the same picture from 20 unimpaired participants. They considered that every **concept** that was mentioned by seven of the 10 speech pathologists was essential to the picture description and therefore identified as a **main concept**. When these concepts were also mentioned by at least 14 unimpaired individuals in their oral descriptions, they were confirmed as main concepts and added to a final list. Some main concepts identified in these studies were very clearly defined pieces of information (e.g. “The woman is doing the dishes”). However, due to the large variability in oral picture descriptions other main concepts were very broad and included a variety of statements (e.g. “some mention of a plausible action by the girl or location of the girl.”). Hence, main concepts rather represent a broad idea or entity that should be mentioned in the picture description than a particular propositional phrase in a participant's description.

In contrast to Nicholas and Brookshire's 70% criterion, Richardson and Dalton (2016) argued that a concept could be considered essential when it was mentioned by at least 33% of participants (in analysis of the picture descriptions [Cinderella story and Broken Window picture sequence] of 92 unimpaired participants). However, they also examined stricter criteria of 50% or 60%, and found that these did not lead to significant changes in the number of relevant main concepts observed.

Some authors have even identified main concepts in the absence of a representative control group (e.g. Capilouto, Wright, & Wagovich, 2005; Ramsberger & Rende, 2002). In these cases, independent raters were asked to identify concepts, as defined above, for a particular target picture or topic of discourse. Any concept that was identified by at least two out of three raters (or a similar proportion in case of more raters) were then defined as main concepts (e.g. Capilouto et al., 2005; Ramsberger & Rende, 2002).

Identifying main concepts in the discourse of individuals with language impairments is more challenging. Due to the lack of content words and/ or grammatical markers the ideas the participants convey are not always clearly interpretable. Hence, adaptations to the previously established definitions of concepts and main concepts are required.

The approach proposed by Nicholas and Brookshire (1995) is that most commonly used to identify main concepts in discourse of speakers with aphasia (e.g. Capilouto et al., 2005; Carragher et al., 2015). Nicholas and Brookshire devised a set of rules to determine which statements can be counted as main concepts. They proposed that, as long as a statement is comprehensible to a listener who is familiar with the target picture and context, it should be counted as a main concept. Hence any grammatical, phonological or semantic errors can be ignored as long as the general idea is conveyed (e.g. "the man dishes drying" instead of "the woman is drying the dishes"). Nicholas and Brookshire suggested that two independent raters should identify main concepts and compare and discuss their results, solving any disagreements by consensus.

Using this approach, Nicholas and Brookshire (1995) found that half of the individuals with aphasia produced fewer main concepts than unimpaired participants. Hence, many of the individuals with aphasia either did not have any deficits in selecting the most important information or this measure was not sensitive enough to discriminate between unimpaired individuals and individuals with aphasia (Nicholas & Brookshire, 1995).

In addition to the identification of main concepts in the participants' discourse, Capilouto et al. (2005) were interested in how concepts were semantically linked. Following Nicholas and Brookshire's (1995) definition of a concept, a sentence like "The man tried to get the cat, but his ladder fell and now he is stuck." would have been split into three different concepts: (1) The man tried to get the cat (2) The ladder fell (3) The man is stuck. As a result, the semantic relationship the participant originally expressed between concept (2) and (3) would be lost for further analyses. Consequently, Capilouto and colleagues accepted statements that contained more than one verb as main concepts, so that the relationships expressed between individual entities could be assessed.

However, not all individuals with aphasia are able to convey links between ideas verbally or link them correctly. Hence, poorly linked ideas could simply be a consequence of the linguistic impairments rather than impaired conceptualisation. Analysing the order in which the participants present information regarding an event (verbally and non-verbally) might circumvent this issue.

As discussed earlier, the order in which information is produced is assumed to reflect the participants' conceptualisation of relationships between individual information units and is also considered less dependent on the participants' linguistic abilities (e.g. Carragher et al., 2015; Manning & Franklin, 2016) than the number of concepts produced. Therefore, unusual ordering might be a valuable marker for conceptualisation difficulties. Such an analysis could get us one step closer to solving the diagnostic dilemma of distinguishing between spontaneous speech symptoms that are primarily caused by linguistic impairments and symptoms that might be underpinned by conceptualisation difficulties.

Study aim

In this study we aimed to identify evidence for possible conceptualisation deficits in a larger population of individuals with aphasia by examining two macrostructural elements in a picture description task: information selection (e.g. number and quality of main concepts) and information order (e.g. order of main concepts). We predicted that individuals with conceptualisation deficits would produce fewer main concepts, more irrelevant detail and have greater variability in the ordering of main concepts than unimpaired participants. To examine the extent to which these measures were affected by linguistic deficits, we evaluated the influence of (1) the number of words, verbs, and nouns; as well as, (2) the participants' verb and object naming ability. In particular, we expected poor verb production to be associated with macrostructural difficulties.

General method

Participants

All participant data in our study was obtained from the AphasiaBank database (MacWhinney, Fromm, Forbes, & Holland, 2011). Different research groups contributed data to AphasiaBank from 293 different English-speaking individuals with aphasia and 193 unimpaired individuals. Every participant was assessed following the same test protocol. This protocol included speech and language assessments like the Western Aphasia Battery (WAB; Kertesz, 1982), the "Verb Naming Test" (VNT; Cho-Reyes & Thompson, 2012), various picture description tasks, medical history and demographic information about each participant. We excluded all participants who were reported to have visual impairments like neglect or hemianopia (Aphasia: 3; Controls: 0) or were left-handed (Aphasia: 40; Controls: 12). We then selected the first 50 unimpaired participants in the database and randomly selected 50 individuals with aphasia (using random number generation). After first inspection of the picture description data we had to exclude three further participants with aphasia who did not produce any analysable verbal response (e.g. they just shook their head). We subsequently selected three new individuals with aphasia to give a total of 50 participants in each group. A comparison of the demographic data of both experimental groups revealed an age difference, with the mean age of unimpaired participants being slightly, but significantly higher than the mean age of individuals with aphasia (Unimpaired individuals: mean age = 72;8 ± 6;1; Individuals with aphasia: mean age = 69;1 ± 11;4; $t(98) = 2.0319$: $p = 0.04487$). No significant differences were found in the gender distribution (Unimpaired individuals: 25 females, Individuals with aphasia: 25 females) or in mean years of education (Controls = 15.2 years; Individuals with aphasia: 15.5 years).

The type of aphasia was determined with the WAB. The sample included 19 individuals with Broca's aphasia, 11 with conduction aphasia, 15 with anomic aphasia, 3 with Wernicke's aphasia, 1 with trans-cortical sensory aphasia and 1 remained unclassified. The severity of impairment, as defined by Western Aphasia Battery Aphasia Quotient, ranged (WAB-AQ; Kertesz, 1982) from mild (maximum WAB-AQ = 96.1) to severe (minimum WAB-AQ = 45.5; overall mean WAB-AQ = 72.2 ± 14.4). Fluency of speech was recorded in the database as determined by the clinical impression of the AphasiaBank contributor (non-fluent: 22 (19 Broca's, 3 anomic); fluent: 28). A comparison of the severity of aphasia measured by WAB-AQ between participants classified as fluent or non-fluent revealed a significantly more severe impairment in non-fluent speakers (non-fluent: 67.6 (12.9); fluent: 76.8 (14.5); $t(48) = -2.35$; $p < .05$). We also extracted Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1883) and VNT (Cho-Reyes & Thompson, 2012) results for all individuals with aphasia from the AphasiaBank database (see Appendix A for complete list of demographics).

Materials

The connected speech samples in this study were elicited using the "Cat Rescue" picture (Nicholas & Brookshire, 1993; see Figure 1).

Nicholas and Brookshire developed this task to prompt narrative discourse in form of a story-like picture description. In order to accurately describe the picture, participants had to infer interactions between the depicted elements. The protocol required each participant to "*describe the picture by telling a story with a beginning, a middle and an end.*" (MacWhinney et al., 2011, p. 1288). Transcripts and videos of each picture description were available on the AphasiaBank database. Consequently, both verbal and non-verbal responses were used for our analysis of main concepts and non-main concepts (see Analysis 2 for further detail).

Experimental investigation

We conducted six different analyses to provide a comprehensive overview on the quality, number and order of main concepts in the participants' picture descriptions:

(1) Identification of concepts and main concepts in unimpaired speakers
(2) Analysis of main concepts in individuals with aphasia
(3) Analysis of non-main concept statements
(4) Analysis of the order of main concepts
(5) Analysis of factors influencing concept production

Below, we present the procedure of each analysis immediately followed by the corresponding results.

Analysis 1: identifying concepts and main concepts in unimpaired speakers

In this analysis we first investigated the individual concepts unimpaired subjects produced in their picture description. Guided by Nicholas and Brookshire (1995),

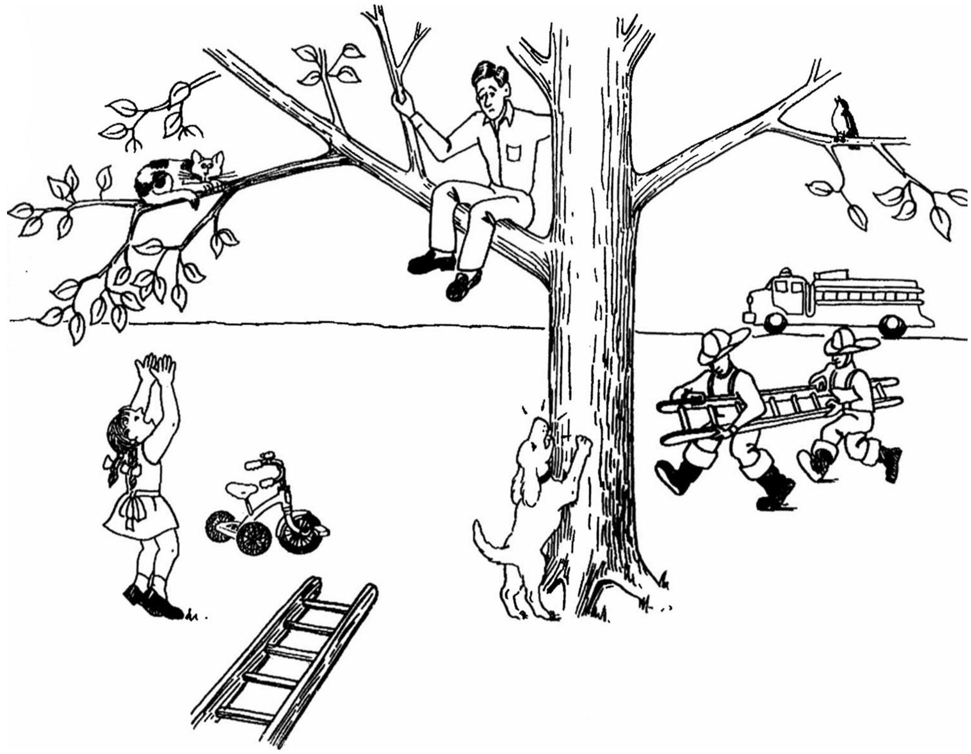

Figure 1. Cat Rescue picture (Nicholas & Brookshire, 1993).

we defined a **concept** as a statement that contains only one verb and conveys information about the picture. Subsequently, we identified which of the concepts produced by unimpaired speakers could be classified as essential to the picture description and therefore identified as **main concepts**.

Concepts

Method

To identify the concepts, we first listed every phrase each participant produced in his or her description. We excluded comments about the participants' own performance (e.g. "that was not good") from further analysis.

We then collapsed across phrases that constituted a single idea (hereafter: concept) by asking three independent raters to identify phrases that expressed a similar meaning despite being differently worded. For example, "*The cat ran up the tree*" and "*The cat got up the tree*" were combined to form a single concept "*The cat climbed/ is in the tree* [**motion or location of the cat*]". The raters were also asked to identify when a listed phrase conveyed two different concepts. For example, the phrase "*The dog chased the cat up the tree.*" was treated as two different concepts in our analysis: *(1) The dog chased the cat* and *(2) The cat is up the tree*.

Results

We identified 182 different utterances across all unimpaired participants. All three raters agreed in their judgement for 108 phrases (60%), which were sorted into 47 different concepts. A decision about the remaining 74 phrases was gained by consensus, resulting in 8 further concepts. Hence, all 182 utterances were merged into 57 different concepts (see Appendix B).

Main concepts

Of the 57 concepts identified, some, however, were mentioned by few or even only one unimpaired participant and showed only marginal relevance to the core story depicted (e.g. "*The man thinks he is a squirrel.*"). Thus, the next analysis determined which of the identified concepts were relevant to the depicted story and were, therefore, main concepts.

Method

Our study included a larger control sample than that previously reported by Nicholas and Brookshire (1995). Hence, we decided to adopt a more liberal criterion for the definition of a main concept: We followed Richardson and Dalton (2016) and decided that statements that were produced by 60% or more unimpaired participants can be identified as main concepts (rather than 70% for Nicholas and Brookshire). This (admittedly arbitrary) decision was also based on the assumption that a concept that was produced by more than a half of all unimpaired participants must be relevant and important to the depicted story.

Results

We identified eight concepts that were mentioned by more than 60% of all unimpaired participants. Critically, we found that no individual concept about the depicted entities GIRL and DOG reached the 60%-threshold. However, the entities themselves were mentioned by the majority of unimpaired participants (GIRL: 90% of participants, e.g. *The girl is crying*; *The girl wants the cat; The girl is standing there*; DOG: 62% of participants, e.g. *The dog is barking; The dog is worried; The dog tries to bite the man*). This was not the case for statements about other depicted entities like BIRD (30%) and TRICYCLE (0%). We therefore concluded that while control participants were not sure about the exact role of the entities GIRL and DOG in the depicted event, for the majority of participants these entities were perceived as relevant. Consequently, following the approach of Nicholas and Brookshire (1995), we merged all concepts that were produced about the GIRL or about the DOG and included them as broadly defined main concepts representing "*any mention*" of the entities ("*Any mention about the girl* [**negative emotion, action, location*]"; "*Any mention of the dog* [**appearance, mood, motivation, action*]") in our final main concept list. The final list therefore comprised 10 main concepts for the Cat Rescue picture (see Table 1).

On average, unimpaired individuals produced 8.14 (SD: ±1.14) main concepts in their picture description.

Analysis 2: main concepts in individuals with aphasia

Method

In this analysis we identified main concepts in the picture descriptions of individuals with aphasia. Following the approach of Nicholas and Brookshire (1995), any statement that could be understood by a listener who is familiar with the target picture and the context, and could be assigned to one of the 10 main concepts, was identified as a main concept. As long as this criterion was fulfilled,

Table 1. List of main concepts that were mentioned by more than 60% of unimpaired participants, alternative wordings for each concept and the position in which they were produced within the description.

Order[a]	Main concept	Alternative	Mentioned by (%)[b]
A	The cat climbed/ is in/ is stuck in the tree [*motion up or *location]	e.g. hiding in the tree/ sitting in the tree/ is stuck/ needs to be rescued/ won't come down/ caught/ won't jump down, got up/ ran up [*any kind of movement to get up the tree]	96
B	Any plausible mention of the girl [*negative emotion/ *plausible action/ plausible location]	e.g. is worried/ is upset/ is crying/ is helpless/ is shouting/ is calling the cat/ screaming for the cat/ trying to get the cat/ hopes the cat will fall in her arms/ cannot reach the cat/ tries to catch the cat/ is standing underneath the tree / noticed her cat/ found the cat/ is off the bike/ is on the ground/ was on her bike/ sees her cat in the tree/ finds the man in the tree/ playing with the cat and the dog/ playing in the park/ was riding the bicycle/ lost the cat/ get her dad/ called her dad/ summoned her dad/ yelled for help/ told her mother/ asked the man to help/ called the dog to help	90
C	The man wants to get the cat [*plausible motivation to climb the tree]	e.g. wants to rescue the cat/ cannot reach the cat/ tried to get away from the dog [*any plausible motivation that explains why the man is in the tree]	74
D	The man climbed/ is in/ is stuck in the tree [*motion up or *location]	e.g. went up/ goes up/ got up/ got himself up [*any kind of movement to get up the tree], is in/ is sitting/ is stuck/ is caught	98
E	The ladder is lost [*any indication that the ladder cannot be used]	e.g. the ladder fell down/ got out/ dog knocked the ladder over/ wind blew the ladder over	72
F	Any plausible mention of the dog [*any expression that indicates "making noise"/ *appearance/ *motivation]	e.g. growling/ making a lot of noise/ disturbs everyone/ went bananas/ comes/ is there/ is upset/ is concerned/ wanted to see where the man went/ thinks this is crazy/ trying to help the man down [*any motivation that explains why the dog is there/ barking]	60
G	Someone [*any indication of a person] must have called the fire brigade	e.g. the mother called/ I don't know how they got the fire brigade/ neighbours called/ girl called [*any explanation or mention of how the fire brigade knew that they had to come]	66
H	The fire brigade is coming [*any mention of their arrival at the scene]	e.g. fire brigade is there/ fire brigade is going by/ arriving/ comes running/ driving the truck over/ showing up [*any mention of the fire brigade's arrival at the scene]	94
I	The fire brigade brings a ladder [any indication of them having/ bringing a second ladder]	e.g. brought a ladder/ carrying a ladder OR together with concept: coming with a ladder / showing up with a ladder	68
J	The fire brigade rescues them [*help/rescue or anything similar]	e.g. retrieves the man/ helps the man and the cat/ gets them down/	96

[a]Order = Position relative to other concepts in which the concept was mentioned most often.
[b]Mentioned by (%) = Percentage of controls who produced the specific concept.

grammatical, phonological and/or semantic errors were ignored However, we also made minor adjustments to the analysis procedure proposed by Nicholas and Brookshire (1995). Since we were interested in how the participants conceptualise the picture in terms of the information they deem relevant and choose to convey, rather than in their ability to linguistically express this information, we accepted both verbal and non-verbal responses (e.g. "*this {points: cat} and {slides finger up the tree} and man {slides finger up the tree}*"). In addition, if a participant named one of the depicted entities or pointed at one of them without giving additional information, the response was scored as an instance of the main concept about the respective entity that was mentioned by most of the unimpaired controls (e.g. "*man {pointing at man}*" =and instance of the main concept "*The man climbed/ is in the tree*"; *see Appendix B)*. There were only 18 main concepts of this kind (of the 263 main concepts identified for participants with aphasia) and this only applied to eight participants with aphasia.

After the first author had identified all main concepts in the participants' picture descriptions, we randomly selected 20 descriptions which were analysed by a second independent rater. The raters agreed in their identification of 95% of main concepts. In case of disagreement a decision was made by consent. All utterances that could not be assigned to a main concept were listed separately.

Results

A two-sample t-test revealed that individuals with aphasia produced significantly fewer main concepts than the group of unimpaired participants (mean: 6.08 (SD: ±1.98); t (98) = −6.559; $p < .001$, see Table 3). Crawford and Howell's modified t-test for single cases (singlims, Crawford, Garthwaite, Azzalini, Howell, & Laws, 2006) indicated that participants who produced less than seven main concepts (MC), differed significantly from unimpaired participants (6 Main concepts: $t = -1.86$; $p = .034$).

Table 3. Mean, standard deviation and intercorrelations of the number of main concepts and number of words, verbs and nouns for unimpaired participants.

	#non-main concepts *r*	word *r*	verbs *r*	nouns *r*
Number of main concepts	.32*	.42*	.30*	.47**
Number of non-main concepts		.70***	.58***	.62***
Number of words		–	.86**	.87**
Number of verbs			–	.71**
Number of nouns				–

***$p < .001$; **$p < .01$; *$p < .05$.

This analysis showed that half (25) of the individuals with aphasia produced significantly fewer main concepts than unimpaired subjects (see shaded area in Figure 2).

Of the individual main concepts, eight were produced by significantly more unimpaired participants than individuals with aphasia (Fisher-exact: all $p < .01$ (one-tailed), see Figure 3). In contrast, significantly more individuals with aphasia produced a main concept about the DOG (Fisher-exact: $p = .0125$, see Figure 3). However, just as many individuals with aphasia as unimpaired participants produced a main concept relating to the GIRL (see Figure 3).

Discussion

In line with our predictions, we found that some individuals with aphasia produced significantly fewer main concepts than unimpaired participants. Interestingly, this finding is not consistent across all individual main concepts. Consequently, we suggest that the participants' expressive language impairment might not be the only explanation for the reduced number of main concepts. Conceptualisation impairments would be another possible explanation for the reduced number of main concepts in this first analysis. Cairns et al. (2007) hypothesised that conceptualisation impairments would be characterised by the production of a relatively large amount of irrelevant detail. Consequently, the next analyses evaluate the production of non-main concepts, comparing the production of unimpaired speakers and the individuals with aphasia.

Analysis 3: non-main concept statements

Method

We first counted the number of statements that did not concern one of 10 main concepts in the group of

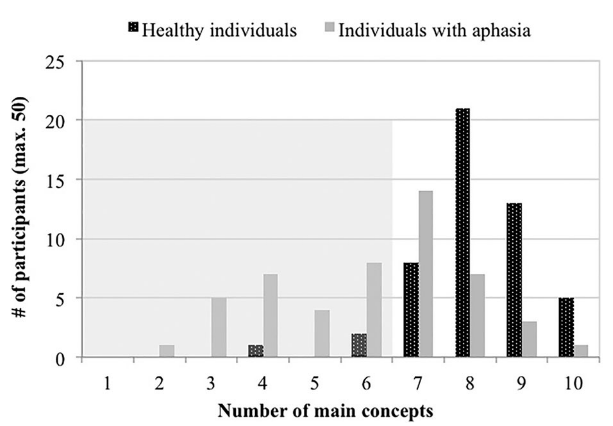

Figure 2. Frequency of total number of main concepts produced per narrative by unimpaired participants and individuals with aphasia. (Shaded area indicates the number of main concepts that are significantly lower than the unimpaired subjects).

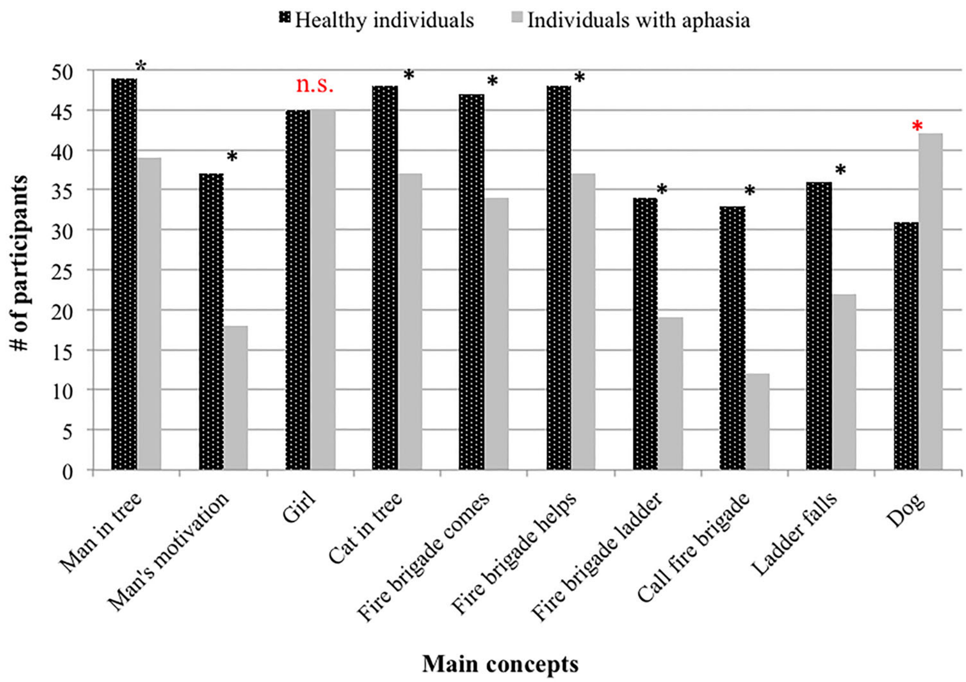

Figure 3. Number of individuals with aphasia and unimpaired individuals that produced each individual main concept (*= $p < .05$ (Fisher Exact Test), n.s. = $p > .05$).

unimpaired participants. We identified three different types of non-main concept statements in their picture descriptions: (1) plausible ideas that were produced by less than 60% of all unimpaired participants (e.g. "*the man is afraid to come down*"), (2) general comments (e.g. "*this is a real mess*"; "*that's the end*") and (3) marginally relevant information. Marginally relevant information was defined as statements that could not be plausibly inferred from the picture (e.g. "*the man thinks he is a squirrel*"; "*mom looks out of the house*") or detail (e.g. "*the girl has a ponytail*"). These three categories were sufficient to categorise all the utterances for unimpaired speakers, however, for people with aphasia it was necessary to define two new categories: (4) semantically empty/indeterminate statements (e.g. "*he is could have in her hurry*") and (5) associations (e.g. for FIRE BRIGADE: "*I worked for those*").

Results

Unimpaired participants produced on average 1.44 (SD: 1.77; range 1–11) non-main concept statements per picture description. Individuals with aphasia produced, on average, significantly more non-main concept statements than unimpaired individuals (mean = 2.52 (SD: 2.55; range 1–10); t (98) = 2.681; $p < .01$). Single cases analysis (singlims, Crawford et al., 2006) indicated that participants with aphasia who produced more than five non-main concepts, differed significantly from unimpaired controls (5 non-main concepts: $t = 1.991$; $p < .026$). We identified 11 individuals with aphasia who produced significantly more non-main concepts than unimpaired participants, two of whom also produced a significantly lower number of main concepts.

The majority of the unimpaired participants' non-main concept statements were plausible ideas (49%) or general comments (32%; see Table 2). Comments were used to express narrative structure of the picture description (e.g. "*this is the end*"; "*they lived happily ever after*") or to give a general remark about the scene (e.g. "*we have a*

Table 2. Distribution of non-main concept statements in unimpaired individuals and individuals with aphasia and comparison between non-main concepts statements produced in both groups (Mann-Whitney U – test).

	Controls		Individuals with Aphasia		Controls vs. Individuals with Aphasia	
	Total (%)	Mean (SD)	Total (%)	Mean (SD)	z	p
Plausible ideas	35 (49%)	0.7 (1.07)	46 (36%)	0.9 (1.6)	.95	.17
Comments	23 (32%)	0.46 (0.61)	31 (25%)	0.62 (1.14)	.80	.21
Marginally relevant information	14 (19%)	0.28 (1.03)	26 (21%)	0.52 (0.90)	2.08	.019*
Associations	0 (0%)	0	4 (3%)	0.08 (0.34)	1.45	.073
Semantically empty	0 (0%)	0	19 (15%)	0.38 (0.75)	3.55	<.001***

***$p < .001$; **$p < .01$; *$p < .05$.

real mess here"). Of the 14 non-main concepts classified as marginally relevant information, half were produced by a single participant. The remaining seven marginally relevant non-main concepts were produced by seven different participants.

A Chi-square test revealed a significant difference between the overall pattern of non-main concept statements produced by unimpaired participants and individuals with aphasia (χ^2 (4) = 15.72; $p < .01$). As for unimpaired individuals, individuals with aphasia most commonly produced plausible ideas (e.g. "*maybe the man jumps off*"), comments (both structural (e.g. "the next thing that is happening is"), and general comments (e.g. "*that's kind of funny*")) and marginally relevant information (e.g. "*the girl has ponytails*"). Overall, participants with aphasia mentioned significantly more marginally relevant statements than unimpaired participants (see Table 2). However, none of the participants with aphasia produced more than four of these statements within one picture description.

Further we observed the production of some associative information (e.g. "*I have firemen in my family*") and semantically empty statements, which none of the unimpaired participants produced. Individuals with aphasia produced significantly more semantically empty statements than unimpaired participants (see Table 2).

Discussion

As predicted, our results showed that, on average, individuals with aphasia produced more non-main concepts than unimpaired individuals. Nevertheless, the proportion of participants who showed an increased number of non-main concepts was relatively small (11 out of 50 participants). For these individuals, we suggest that conceptualisation difficulties could underpin the increased number of non-main concepts.

However, the pattern of increased production of non-main concepts was was not consistent across all subtypes of non-main concepts. In line with Cairns et al.'s (2007) hypothesis, we found that, overall, participants with aphasia in our sample produced significantly more marginally relevant information than unimpaired participants. Nevertheless, we did not identify any individual with aphasia who produced an overly detailed picture description as reported for some cases with possible conceptualisation difficulties (e.g. Cairns et al., 2007). Interestingly, the non-main concepts produced by participants with aphasia in our study were not simple listings of details, as reported for the case of Ron (Cairns et al., 2007). It is possible that more complex scenes, like the "Cat Rescue", elicit different kinds of non-main concepts than simple event pictures as used by Cairns et al. (2007).

To further support the hypothesis of underlying conceptualisation deficits in some of the people with aphasia, we investigated the order in which the participants produced the individual main concepts in Analysis 4.

Analysis 4: order of main concepts

Putting information in an order that makes it easy for the listener to follow is an essential part of conceptualisation. Thus, a large discrepancy between the main concept order of an individual with aphasia and the group of unimpaired subjects could point to conceptualisation difficulties. To investigate if the participants with aphasia were able to understand and convey links between given information despite their speech production impairments, we analysed the order in which this information was mentioned.

Method

We first identified the exact main concept order of each unimpaired individual and calculated the median position for each main concept across the group of unimpaired individuals (see Order column in Table 1, earlier). Next we calculated a Difference-in-Order-ratio (DiO ratio) to determine the difference between the individual main concept order in each participant's (unimpaired and participants with aphasia) picture description and the median main concept order was established on the basis of the picture description of the unimpaired speakers in this study (see Appendix C for full description of the method). This DiO ratio can have any value between 0 and 1 and for each individual represents the number of differences from the median main concept order. Hence, the higher the DiO ratio the larger the deviation between an individual's order of main concepts and the median main concept order. For example, if a participant produced all ten main concepts and showed two differences from the median concept order (e.g. producing concepts in the order: **2** - 1 - **4** - 3 - 5 - 6 - 7 - 8 - 9 - 10) the DiO-ratio would be 0.04. Changes in the DiO ratio also depended on the number of total main concepts the participants produced. For example, if a participant only produced eight main concepts and two differences from the main concept order the DiO ratio would be 0.07 (a larger difference from the median order than the 0.04 for two differences and 10 main concepts).

We also compared the main concepts unimpaired speakers and individuals with aphasia produced at the beginning and the end of their picture descriptions. This provided qualitative information about possible differences in the global coherence of the picture descriptions of both groups.

Results

Unimpaired speakers showed on average a DiO ratio of 0.08 (SD: 0.12). In more descriptive terms this means that unimpaired participants produced on average 8.14 main concepts with about 2 differences from the median concept order we established. On an individual level we observed that 98% of the unimpaired participants produced between 0 and 6 differences (median: 1) from the median concept order.

Results of single case statistics (Crawford et al., 2006) showed that nine individuals with aphasia produced a significantly higher DiO ratio than the unimpaired participants ($DiO \geq 0.33$; $p < .03$). Seven of these participants were amongst those participants who also produced significantly fewer main concepts and one significantly more non-main concepts than the unimpaired participants.

The remaining 41 individuals with aphasia showed no significant differences from the mean DiO ratio of unimpaired speakers ($DiO_I < 0.29$; $p > .05$).

Qualitative analysis showed that the majority of unimpaired participants (83%) produced main concepts about the CAT, the GIRL and the MAN in the first three positions of their picture description. In contrast, significantly fewer (52%) individuals with aphasia who produced a main concept about each of these entities, mentioned them within the first three positions of their description (Fisher exact-test: $z = 2.64$, $p = .004$; see Figure 4).

The main concept *"Any mention of the DOG"* appeared to be predominantly responsible for this observed difference. Most unimpaired subjects who produced a concept about the DOG produced it in fifth or sixth position (55%). Only 26% of individuals with aphasia who produced a main concept about the DOG, produced it in the same position. Instead, 42% of individuals with aphasia placed this concept in the second or third position of their picture description. For example, 71% of unimpaired speakers produced a concept about a LADDER before a concept about the DOG while only 35% of the individuals with aphasia produced this same order.

In contrast, the analysis of the end of the picture descriptions showed that 90% of all unimpaired participants who produced a main concept about the FIRE BRIGADE mentioned it in the last position. Similarly, 88% of all individuals with aphasia who produced at least one main concept about the FIRE BRIGADE mentioned it at the end of their picture description (Fisher exact-test: $z = 0.07$, $p = .47$; see Figure 4).

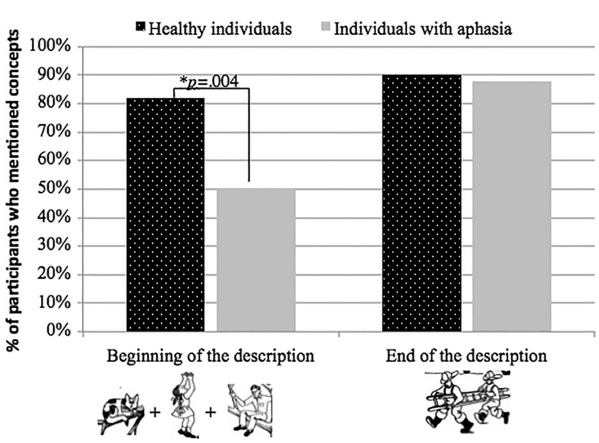

Figure 4. Proportion of participants who produced the same main concepts in the beginning and/ or end of the picture descriptions.

Discussion

In line with our hypothesis, we observed a large variability in the order of main concepts in individuals with aphasia that was especially salient in the beginning of the participants' picture description. Moreover, we identified nine individuals who showed an order of main concepts that was significantly different from unimpaired participants. We consider it possible that these order differences might be explained by underlying conceptualisation difficulties in some people with aphasia.

However, it is also possible that linguistic impairments such as word retrieval deficits could have influenced the order of concept production. For example, some of the participants with aphasia may have chosen to produce first those concepts for which they could retrieve lexical items. Consequently, in the next analysis we further investigate which factors might influence concept production.

Analysis 5: factors influencing concept production

In order to find out more about how the nature of the impairment might influence the observed symptoms, we examined if, and in what ways, the participants' linguistic impairments (i.e. number of words, number of verbs; Verb Naming Test scores, Boston Naming Test scores) and grammatical difficulties (i.e. fluency of speech) affected production of main concepts and non-main concepts.

Method

We first examined the correlations between the number of main concepts and number of non-main concepts and measures of linguistic output: number of words, verbs and nouns for participants with aphasia and unimpaired participants (Pearson's correlations). For the individuals with aphasia we additionally calculated these correlations for our measure of how far the order of main concept in the picture description of each participant with aphasia differed from controls (Difference in order ratio; DiO).

We also examined the correlation between our three main outcome measures (#main concepts, #non-main concepts, DiO) and the participants with aphasia's ability to name nouns and verbs in the Boston Naming Test and the Verb Naming Test. Moreover, in order to tease apart the relative contribution of each measure we supplemented the correlations with linear regressions. We use Evans' (1996) criteria for describing the strength of the correlations (e.g. weak: $r = .20–.39$; moderate: $r = .40–.59$; strong: $r = .60–.79$).

Finally, to gain information on the influence of grammatical difficulties, we conducted a one-way ANOVA to investigate if the participants' fluency of speech had a significant effect on any of the outcome measures.

Results

Unimpaired participants: main concepts

In unimpaired participants, Pearson's correlations revealed mild to moderate correlations between the number of main concepts and the number of words, verbs and nouns (see Table 3), with no significant differences in the strength of these correlations (*Fisher z-transformation* (Fisher, 1915): $z_{\text{words vs. verbs}} = .67$, $p = .25$; $z_{\text{words vs. nouns}} = -.67$, $p = .38$; $z_{\text{nouns vs. verbs}} = .97$, $p = .16$).

Unimpaired participants: non-main concepts

The number of non-main concept statements was also strongly correlated with the overall number of words, verbs and nouns in the participants' picture descriptions (see Table 3). In other words, unimpaired subjects who produced generally longer picture descriptions were more likely to produce more non-main concept statements. Critically however, the size of these correlations was mainly driven by one unimpaired subject who appeared to be an outlier and produced the highest number of non-main concepts and words in the sample. If this participant is removed from the analysis the correlation coefficients dropped substantially and the correlation between the number of non-main concept statements and verbs was no longer significant ($r_{\text{non-main concepts \& words}} = .37$, $p = .010$, $r_{\text{non-main concepts \& verbs}} = .25$, $p = .082$ and $r_{\text{non-main concepts \& nouns}} = .4$, $p = .005$). Similarly, the observed correlation between the number of main concepts and the number of non-main concepts, is no longer significant, when this one participant was removed from the data ($r_{\text{main concepts \& non-main concepts}} = .23$, $p = .117$).

Individuals with aphasia: main concepts

As in the group of unimpaired subjects, we found a significant moderate correlation between the number of main concepts and the number of words, verbs and nouns in the picture descriptions of participants with aphasia (see Table 4). Moreover, our results showed a moderate correlation between the number of main concepts individuals with aphasia produced and their verb naming.

Given the high intercorrelations between many of the measures, we carried out linear regressions to further investigate the influence of the measures when shared variance is accounted for. In order to prevent multicollinearity we only included variables with a sufficiently low intercorrelation ($r < .80$; Hutcheson & Sofroniou, 1999). Thus we ran one model including number of words (but not number of verbs and number of nouns), and a second including number of nouns and verbs (but not number of words). All models included the Verb Naming Test, Boston Naming Test, number of non-main concepts and DiO ratio as predictors (see Table 5).

Production of a larger number of verbs or words as well as high VNT score were significant predictors of a higher number of main concepts. Hence, two measures of verb production, the VNT and the number of verbs, appear to be the best predictors for the number of main concepts in the picture descriptions of individuals with aphasia.

Table 4. Intercorrelations between outcome measures for individuals with aphasia.

r =	# non-main concepts	DiO-ratio	words	verbs	nouns	BNT	VNT
Number of main concepts	.39**	−.06	.52***	.55***	.49***	.26	.42**
Number of non- main concepts	–	.31*	0.84****	.70***	.64***	−.011	−.013
Difference in order ratio (DiO ratio)		–	0.11	.07	.09	−.32*	.30*
Number of words			–	.84***	.83***	−.01	−.09
Number of verbs				–	.67***	−.06	−.01
Number of nouns					–	.11	.14
Boston Naming Test						–	.63***
Verb Naming Test							–

***$p < .001$; **$p < .01$; *$p < .05$.

Table 5. Results of linear regressions to identify predictors for the number of main concepts in individuals with aphasia.

	B	SE *B*	*ß*	*t*	*p*
Model 1 (Nouns & Verbs): $R^2 = .423$, $p < .001$					
verbs + #nouns + VNT + BNT + #non-main concepts + DiO ratio					
#verbs	.090	.035	.45	2.61	.012*
#nouns	.012	.027	.07	.432	.67
VNT	.122	.043	.40	2.81	.007**
BNT	.005	.017	.04	.268	.79
#non-main concepts	.07	.133	.09	0.52	.61
DiO ratio	.03	1.29	.003	0.02	.98
Model 2 (Words): $R^2 = .431$, $p < .001$					
words + VNT + BNT + #non-main concepts + DiO ratio					
#words	.015	.005	.62	3.00	.004**
VNT	.151	.042	.50	3.58	<.001***
BNT	−.006	.018	−.05	−.330	.743
#non-main concepts	−.061	.163	−.08	−.375	.709
DiO ratio	.251	1.29	.02	.193	.848

***$p < .001$; **$p < .01$; *$p < .05$.

Individuals with aphasia: non-main concepts

The number of non-main concept statements in the participants' picture descriptions was also strongly correlated with the number of words, verbs and nouns. In contrast to unimpaired participants however, these correlations were not driven by one individual.

Once again we carried out linear regressions, including the same predictors as for the main concept analysis above, but with main concepts replacing non-main concepts. Results showed that a high number of non-main concept statements in the participants' picture descriptions were predicted by a higher DiO ratio and production of more words or more verbs and nouns (see Table 6).

In a further analysis, we found no significant correlations between the number of statements falling in the "marginally relevant" subcategory of non-main concepts and either the number of main concepts or the DiO-ratio ($r_{\text{marg.relevant \& \#MC}} = .2$, $p = .16$; $r_{\text{marg.relevant \& DiO}} = .21$; $p = .130$).

Table 6. Results of linear regressions to identify the best predictors for the number of non-main concepts in individuals with aphasia.

	B	SE *B*	*ß*	*t*	*p*
Model 1 (Nouns & Verbs): $R^2 = .58$, $p < .001$					
# nouns + #verbs + BNT + VNT + #main concepts + DiO ratio					
#nouns	.072	.029	.32	2.48	.017*
#verbs	.119	.039	.43	3.08	.004**
BNT	.006	.021	.03	.283	.77
VNT	−.064	.053	−.16	−1.21	.23
#main concepts	.091	.174	.07	0.52	.61
DiO ratio	2.99	1.41	.21	2.12	.039*
Model 2 (Words): $R^2 = .73$, $p < .001$					
#words + BNT + VNT + #main concepts + DiO ratio					
#words	.028	.003	.84	8.87	<.001***
BNT	−.010	.016	−.06	−.60	0.55
VNT	.024	.044	.06	0.54	0.59
#main concepts	−.052	.139	−.04	−0.38	0.71
DiO ratio	2.92	1.11	.21	2.62	.012*

***$p < .001$; **$p < .01$; *$p < .05$.

Individuals with aphasia: order

We found significant correlations between the participants with aphasias' DiO ratio and the number of non-main concepts they produced in their picture description, their BNT score and VNT score (see Table 4, earlier). Nevertheless, linear regression (see Table 7) revealed a high number of non-main concepts as the only significant predictor for a higher DiO ratio. Critically however, the linear regression model only reached significance in the model with number of words as a factor rather than numbers of nouns and verbs. Moreover, it is interesting to note that the amount of the variance explained for the DiO ratio was much smaller than for the linear models examining predictors of the participants' number of main concepts and non-main concepts.

Individuals with aphasia: fluency

Finally we examined the effect of rated fluency on performance. Non-fluent speakers produced significantly fewer main concepts than fluent individuals with aphasia ($t(98) = -2{,}48$: $p = .017$). However, when we performed an ANCOVA analysis in which the severity of impairment represented by the WAB-AQ was added as a covariate, the significant effect of fluency disappeared (post-hoc Tukey's HSD test: $p = .112$).

Similarly, there was not a significant effect of fluency for the number of non-main concepts or DiO ratio with severity of impairment (WAB-AQ) as a covariate (non-main concepts: $F(1,1) = 1.478$, $p = .23$; DiO-ratio: $F(1,1) = 0.539$, $p = .46$).

Discussion

Unimpaired participants

Perhaps unsurprisingly, for unimpaired participants, the more words, nouns or verbs a participant produced, the more main concepts and non-main concepts were

Table 7. Results of linear regressions to identify best predictors of the difference-in-order-ratio in individuals with aphasia.

	B	SE *B*	*ß*	*t*	*p*
Model 1 (Nouns & Verbs): $R^2 = .12$, $p = .074$					
# nouns + #verbs + BNT + VNT + #main concepts + #non-main concepts					
#nouns	.001	.003	.04	0.22	.83
#verbs	−.001	.004	−.29	−1.31	.20
BNT	−.003	.002	−.23	−1.33	.19
VNT	−.003	.006	−.10	−0.54	.59
#main concepts	.0003	.018	.004	0.02	.98
#non-main concepts	.031	.015	.44	2.12	.039*
Model 2 (Words): $R^2 = .16$, $p = .025$*					
#words + BNT + VNT + #main concepts + #non-main concepts					
#words	−.001	.001	−.47	−1.73	.09
BNT	−.002	.002	−.16	−0.95	.35
VNT	−.005	.006	−.17	−0.87	.39
#main concepts	.003	.018	.04	0.19	.85
#non−main concepts	.046	.018	.65	2.62	.012*

***$p < .001$; **$p < .01$; *$p < .05$.

produced. Due to the naturally high intercorrelations between the number of words and the number of nouns and verbs, it seems likely that verbs and nouns were a major driver of the effect of the number of words.

Individuals with aphasia

Similar to the unimpaired participants, we found that individuals with aphasia who produced more words, nouns, and verbs were more likely to produce more main concepts. Again, high intercorrelations suggest that the number of verbs and nouns were strongly driving the overall effect of words.

Moreover, our results showed that production of a large number of non-main concepts was associated with a larger difference in the order in which concepts were produced relative to the controls. Nevertheless, only two individuals produced a significantly larger number of non-main concepts in combination with a significantly higher DiO ratio. We suggest that this combination of symptoms may indicate underlying conceptualisation difficulties for these two participants with aphasia. In addition, we also identified 7 participants who produced significantly fewer main concepts in combination with significantly different DiO ratios. We suggest that for these participants, there may be an underlying difficulty in selecting the most important information within the picture and this leads to reduced speech output.

Despite the fact that, in the literature, the only patients to have been reported with conceptualisation deficits have been non-fluent/agrammatic (e.g. Cairns et al., 2007; Marshall et al., 1993), our results did not suggest any significant differences between the performance of fluent and non-fluent participants with aphasia. We will discuss this in more detail in the General Discussion.

General discussion

This study focused on conceptualisation, which constitutes the first step of our speech production process and has been argued to be highly interlinked with language (e.g. Levelt, 1989; Slobin, 1996). Single case reports have suggested that individuals with language impairments, such as aphasia, may show discourse difficulties that point to conceptualisation deficits (Cairns et al., 2007; Manning & Franklin, 2016; Marshall, 2009). At a macro-structural level these symptoms have been suggested to include production of (1) a reduced amount of relevant information; (2) a high proportion of irrelevant information (Cairns et al., 2007; Dean & Black, 2005; Marshall et al., 1993); and, (3) sequencing errors in discourse (Manning & Franklin, 2016). This study aimed to extend the previous research by investigating if such symptoms were apparent in the picture description performance of a larger population of individuals with aphasia and to determine possible markers of impairments in macro-structural conceptualisation.

Production of relevant information

While reduced informativeness is a common feature of spontaneous speech in aphasia (e.g. Marini et al., 2011; Nicholas & Brookshire, 1995), it is also described as one of the key symptoms of people with presumed conceptualisation deficits (Cairns et al., 2007). Indeed, half of the participants with aphasia in this study produced a significantly reduced amount of relevant information, represented by a low number of main concepts (<7 main concepts), in their picture descriptions.

Cairns (2006) suggests that people with conceptualisation impairments might have difficulties focusing on depicted events in the same way as unimpaired speakers. To conceptualise a picture for a description, we need to choose which information we talk about and which is assigned to the background. Participants who experience difficulties with this process would fail to determine the information that is central to the story they wish to tell about a picture, the result of which could be production of an arbitrary amount of information (either too much or too little). The reduced number of main ideas we observed in our study could therefore be a possible outcome of such a lack of focus which makes it harder for the participants to retrieve the information necessary to describe the depicted scene. As a result, some participants might have been unable to identify all main events and, consequently, produced fewer main concepts.

Additionally, Marshall et al. (1993) described a link between presumed conceptualisation deficits and poor verb retrieval in a verb picture naming task as well as a limited verb use in picture description. Similarly, Dean and Black (2005) reported naming deficits that were disproportionally more severe for verbs than for nouns in their single cases and suggested this was a consequence of the participants' difficulties in conceptualising verbs. While the participants in our study showed impairments in both verb and noun naming, it was only poor verb naming and a reduced number of verbs in the picture description that were significant predictors of a low number of main concepts: noun naming was not a predictor. Hence, we consider it possible that the association between main concept production and verb production could be a consequence of conceptualisation deficits underlying both symptoms.

However, while the reduction in the number of main concepts is consistent with conceptualisation impairment, there are other factors that should also be considered. First, there is the problem that spontaneous speech is commonly acknowledged to be highly variable, even in unimpaired speakers (e.g. Armstrong, 2002). Indeed, the number of main concepts in the picture descriptions of unimpaired participants in our sample varied between 3 and 10. Consequently, part of the observed variability in the number of main concepts produced by participants with aphasia could be due to this natural variability. However, few unimpaired individuals (6%) produced less than seven main concepts as opposed to 50% of the individuals with aphasia. Consequently, it is unlikely that this can fully account for our data and additional explanations for the reduced number of main concepts in aphasia have to be taken into account.

It is also probable that the reduction in main concept production could partly be caused by the participants' expressive language impairment (e.g. word finding deficits). It seems unsurprising that, in general, those unimpaired individuals and individuals with aphasia, who said less, also produced fewer main concepts. Indeed, reduced informativeness in the discourse of individuals with aphasia has been frequently described (Andreetta, Cantagallo, & Marini, 2012; Armstrong, 2000). However, it is important to note that our analysis included both verbal and non-verbal responses (e.g. pointing, gestures). So, there is at least the possibility that linguistic impairments could be compensated for through non-verbal responses. Nevertheless, none of the individuals with aphasia was specifically encouraged to use non-verbal communication. Hence, some participants with severe expressive difficulties, but intact conceptualisation, could have been reluctant to use non-verbal strategies but may have been able to convey more information if they had.

Moreover, despite the general association, it is clear that reduced verbal output, caused by more severe language impairments, does not necessarily lead to a reduction in main concept production. For example, one participant with aphasia produced a total number of 250 words and 7 main concepts, while another participant with aphasia produced only 37 words but also produced 7 main concepts. It is also important to note that we also identified five individuals with relatively mild expressive impairments (WAB-AQ > 75), who, nevertheless, produced significantly fewer main concepts than unimpaired controls. Consequently, while expressive language impairments might seem like an obvious explanation, we suggest that the reduced number of main concepts cannot be fully explained by linguistic deficits, therefore, supporting our assertion that (nonlinguistic) conceptualisation deficits may contribute to this pattern of performance. We suggest that for future research, an approach that takes non-verbal information into account is preferable to an informativeness measure that focuses on purely verbal measures (e.g. Marini et al., 2011: lexical content; Nicholas & Brookshire, 1995: verbally expressed main concepts).

Consistent with the "Thinking for Speaking" account, Dipper et al. (2005) propose that language impairment might reduce linguistic constraints resulting in individuals with aphasia having problems preparing messages for speech production in a "spiral of impairment". While we do not dispute that this is a possible account for the reduced informativeness we observed in some participants, it is striking that half of the individuals with aphasia were not significantly different from the controls in the number of main concepts produced. Under a spiral of impairment account, one might have thought that most people with aphasia should have presented with symptoms related to reduced linguistic constraints on microstructural planning (e.g. inappropriate perspective changes). Consequently, we would argue that the reduction of linguistic constraints in aphasia cannot alone account for the variety in the participants' macrostructural performance that we observed in this study. Nevertheless, we acknowledge that such symptoms may be difficult to detect in the description of a complex picture, as used here.

Importantly, however, some of the participants whose number of main concepts lay with the range of unimpaired controls, produced the highest numbers of non-main concepts (less relevant information), a pattern which is also associated with presumed conceptualisation deficits (Cairns et al., 2007; Marshall et al., 1993).

Production of irrelevant information

A preponderance of irrelevant or excessively detailed information has been repeatedly reported in single case studies of individuals with presumed conceptualisation impairments (Cairns et al., 2007; Dean & Black, 2005; Marshall et al., 1993). Consequently, we hypothesised that people who had difficulties processing and identifying depicted main events, would produce relatively more irrelevant information (i.e. non-main concepts) in their picture descriptions.

Indeed, our results showed that individuals with aphasia produced significantly more statements that were less central to the depicted event than unimpaired participants. Cairns et al. (2007) hypothesised that this might suggest that some participants with aphasia have difficulties in staying focused on relevant aspects of the target picture and hence appropriately assigning this information to the foreground and background of their descriptions. Our data supports this idea. Individuals with aphasia produced significantly more statements like "the tree has long skinny branches" and "the firemen got boots on" than unimpaired participants. We assume that unimpaired speakers backgrounded these details and therefore did not mention them in their descriptions. In contrast, those individuals with aphasia who mentioned such statements might have experienced difficulties in distinguishing key information from background information.

Importantly, we identified two participants with aphasia who produced a significantly reduced number of main concepts in combination with a significantly increased number of non-main concepts (AphasiaBank ID: ACWT11a & kansas10a). These participants were diagnosed with Wernicke's aphasia and conduction aphasia respectively. Both participants provided relatively fluent and extensive picture descriptions characterised by frequent word finding difficulties.

Given that both a reduced number of main concepts and a large number of non-main concepts have been associated with conceptualisation difficulties (e.g. Dean & Black, 2005), it seems particularly likely that the observed discourse deficits of these two participants were underpinned by conceptualisation deficits. A more detailed investigation of, for example, their non-verbal event-processing abilities would be particularly interesting to confirm this hypothesis.

In contrast to previous reports that associated conceptualisation deficits with a predominantly agrammatic symptom pattern (e.g. Marshall, 2009; Marshall et al., 1993), both of these participants were diagnosed with a fluent variant of aphasia. When we compared the number of non-main concepts produced between fluent and non-fluent speakers (who were likely to be predominantly agrammatic), we found no reliable difference. This seems to suggest that grammatical impairments had no, or only limited, influence on the participants' non-main concept production and does not appear to serve as a reliable predictor for conceptualisation deficits in this sample.

Although we propose that the relatively large proportion of irrelevant information produced by the participants with aphasia in our study is consistent with conceptualisation difficulties, we also have to acknowledge that the relatively large variability in the number of non-main concepts we observed in unimpaired individuals (between 0 and 11 non-main concepts) casts doubt on this claim.

Relatively large amounts of irrelevant information were also previously described in unimpaired speakers by Graham, Patterson, & Hodges (Graham, Patterson, & Hodges, 2004) and was hypothesised to reflect natural variability in picture descriptions (i.e. Cookie Theft). However, we think it probable that in picture description some participants feel pressured to produce very detailed descriptions in order to perform the task especially well. The comparatively large correlation we observed between the unimpaired participants' number of non-main concepts and the number of words and verbs in their descriptions supports this idea. We observed a similarly large correlation in the participants with aphasia. Nevertheless, we suggest natural variability or the lack of time restrictions in the picture descriptions cannot fully account for the large number of non-main concepts in aphasia. This is because, in contrast to unimpaired speakers, a high number of non-main concepts were additionally predicted by a large DiO (Difference-in Order) ratio in the speakers with aphasia. We suggest that this association between non-main concept production and difficulties with order is the result of them both having the same underlying cause: difficulties in conceptualisation. We discuss this in more detail below.

Sequencing of concept production

The participant with presumed conceptualisation deficits reported by Cairns et al. (2007) produced the individual entities of a single event picture in an order that was different from unimpaired participants. Consequently, we hypothesised that conceptualisation disorders in aphasia might be represented in a main concept order that differs from the main concept order of unimpaired speakers.

We indeed observed substantial variability in the order of main concepts produced by individuals with aphasia. This suggests that some people with aphasia might have had difficulties in ordering main concepts in the same way as unimpaired individuals and supports Manning and Franklin's (2016) assertion that examination of the order of information is a valuable addition to discourse analyses in aphasia. However, past studies have only investigated participants' ability to form coherence linguistically (e.g. use of pronouns; Marini et al., 2011). Investigating the order of main concepts made it possible for us to evaluate coherence even when the participants were unable to verbally link their ideas (i.e. main concepts) chronologically or causally link successive information. As an example, one participant with severe expressive impairments conveyed links between individual main concepts as follows: "this here {points: cat} and {slides finger up the tree} . and man {slides finger up the tree}.

We suggest that the large variability in the main concept order of some participants with aphasia might, yet again, reflect a problem in weighing the importance of the depicted events as well as problems conceptualising links between them. Cairns et al. (2007) proposed that such an impairment could lead the participants to treat every entity as equally important and result in an almost arbitrary order. This idea is supported by our finding that an increased number of non-main concepts was a significant predictor of larger order differences.

Another important factor could be that the initiating event for the "Cat Rescue" picture (e.g. the cat climbed the tree and is stuck) needs to be inferred and therefore relies heavily on conceptualisation processes. Capilouto et al. (2005) observed that participants with aphasia produce fewer information units in their descriptions of a single event picture (such as the Cat Rescue scene) than a sequential picture stimulus. They argue that the additional requirement to infer a sequence and links between individual events could account for this observation. Similarly, we suggest that an impaired ability to make inferences about the picture could also explain the large variability in the beginning of the description of some individuals with aphasia. In contrast, the most likely ending of the story – "*The fire brigade comes*" – is depicted as currently happening in the picture and does not need to be inferred. This might make it easier for the participants to conceptualise this event and place it in the narrative.

The structure of the target picture itself could have also affected the order of main concepts the participants produced. For example, the spatial organisation of the Cat Rescue picture might have influenced the order in which people described the depicted events. Chatterjee, Maher, and Heilman (1995) show that even unimpaired participants are more inclined to associate entities on the left side of a picture with the subject position. Although Chatterjee and colleagues' study focussed on sentence comprehension rather than picture description, it is possible that some participants with aphasia, when encountering difficulties identifying the relationship between individual entities, may follow a purely spatial (left to right) approach to ordering the events in their picture descriptions.

The visual salience of the individual entities could have also affected the order of main concept production. Entities that are in a prominent position of the picture (e.g. central) are likely to draw the most attention and hence are likely to be selected as a starting point for the picture description (Black & Chiat, 2003, p. 195ff). This might explain the large variety we observed in the beginning of the picture descriptions of the participants with aphasia. We think it possible that difficulty identifying the importance of each entity in the depicted events and/or the relation between entities, may result in a greater influence of visual saliency. Hence, they might have chosen to start their description with a statement about the DOG, just because it is very salient entity due to its animate nature and depicted in a central position. The role of visual factors in picture description and their interaction with conceptualisation impairments may be a fruitful area for further research.

Importantly, the lack of correlation between the order of main concepts and the number of words the participants produced in their picture description suggests that the ability to establish a meaningful order of main concepts is independent from the ability to produce speech in aphasia. Similar results were reported by Manning and Franklin (2016), who observed that temporal sequencing errors were independent from noun naming and hence, from the severity of the participants' expressive language impairments. Hence, our results support Manning and Franklin's assertion that the order of main concepts could be an especially valuable addition to common discourse analysis measures and we suggest that order sequencing impairments could be a possible predictor of conceptualisation deficits in aphasia.

While there was no overall relationship between language impairment and production of main concepts in a "typical" order, it is still possible that some participants might have been unable to access or retrieve the words that were required to describe a specific part of the scene. Hence, they might have mentioned the main concepts in an order in which they were able to retrieve them with little regard of their contribution to the depicted scene. For example, individuals with aphasia were more likely to produce a concept about the DOG very early (3rd or 4th position) in their picture description than unimpaired participants (DOG mentioned on average in 5th position) and the word DOG is highly familiar and high in frequency. Consequently, DOG might have been easier to retrieve than the names of other entities like LADDER, which 71% of unimpaired participants but only 35% of individuals with aphasia mentioned before DOG. Nevertheless, given that conceptualisation is a precursor of lexical access, it seems unlikely that participants would disregard the temporal and/or causal links they might have conceptualised. If, however, the participants have difficulties to conceptualise these links, then starting with statements about the entities they can retrieve seems a plausible strategy.

Clearly further research is necessary to gain more detailed information on the factors underpinning the observed variability in the order of production of main concepts individuals with aphasia.

Summary and future directions

In summary, this study aimed to investigate possible conceptualisation deficits in individuals with aphasia by analysing the number, content and order of concepts produced in a picture description. Our analysis provides further evidence for findings of previous single case reports that some individuals with aphasia produced less relevant information and more marginally relevant information than unimpaired speakers (e.g. Cairns et al., 2007; Dean & Black, 2005) and seem to have difficulty appropriately ordering the concepts produced (Manning & Franklin, 2016). Our study shows that these symptoms can also be found in a large, randomly selected group of individuals with aphasia. Therefore, we suggest they can be used as markers of a possible nonlinguistic conceptualisation impairment in aphasia. Our findings further suggest that conceptualisation deficits might be more common in aphasia than previously reported.

Future research should focus on further investigations of the conceptualisation abilities of participants who show one or more of the above mentioned symptoms. These tasks could include, for example, non-verbal event-processing tasks (e.g. Byng et al., 1994; Cairns et al., 2007; Marshall et al., 1993) to enable confirmation of the hypothesis of underlying conceptualisation deficits.

Overall, our results provide evidence that the concept analysis we performed, can inform our understanding of conceptualisation skills in aphasia and will constitute a valuable complement to other discourse measures (e.g. Armstrong, 2000; Armstrong et al., 2013; Marini, 2012). We particularly support Manning and Franklin's (2016) proposal that the analysis of the order in which participants with aphasia produce their main concepts is an especially important addition to traditional spontaneous speech analysis approaches. In our study, the order of main concepts was not influenced by any linguistic parameters and may therefore serve as a valuable pointer for conceptualisation deficits which are independent from an individual's language impairment.

Conclusion

In "Alice in Wonderland" the king suggests to "*Begin at the beginning* […] *and go on till you come to the end: then stop*" (Carroll, 1920, p. 182). Our study showed that following this advice could be hard for some individuals with aphasia. The production of a reduced number and/ or unusual order of main concepts as well as a large number of non-main concepts are argued to be possible key symptoms of conceptualisation disorders in aphasia. We propose that they may be used to identify individuals who should undergo further testing of their conceptualisation skills, in order that specifically targeted language therapy can be provided to help these people to tell their story from beginning to end.

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